

# HEATING INJECTION APPARATUS FOR VAPOR LIQUID DELIVERY SYSTEM

## BACKGROUND OF THE INVENTION

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### 1. Field of the Invention

10 This invention relates in general to the fields of vapor liquid delivery system. More particularly, the present invention relates to a vapor liquid delivery system for chemical vapor deposition (CVD) process.

### 2. Description of the Prior Art

15 The controlled deposition of thin organic and inorganic films is an important step in the manufacture of integrated circuits. These films are deposited to remain as an inherent part of the device structure, or to constitute intermediate layers that are used for particular processing steps and then removed. One of the methods  
20 for the deposition of thin films is chemical vapor deposition (CVD).

25 The FIG.1 illustrates a prior vapor liquid delivery system used to CVD process. A three-way valve 105 is used to connect a liquid source 100, a purging gas 130 and a liquid injector 115. The liquid source 100 is atomized and injected into this prior vapor liquid delivery system by liquid injector 115. The atomized liquid source 100 will enter gas-mixing device 120 with other process gases 125. However the liquid source 100 that resides in the front liquid injector



115 has a high risk of contacting with other reactive process gases to induce polymerization, especially soaking in high temperature. And a continuous purging out procedure of the prior vapor liquid delivery system need to be executed by He to purge out the liquid between  
5 valve 105 and injector 115 to prevent polymerization. That would impact machine uptime.

Furthermore, the heating passage of the prior vapor liquid delivery system is also too short to provide enough time to heat  
10 process gases, which has a high potential to reduce the temperature of vapor and cause condensation.

### **SUMMARY OF THE INVENTION**

15 In accordance with the present invention, a heating injection apparatus for vapor liquid delivery system, one object of the present invention is isolated liquid source from reaction chamber efficiently and prevents to induce polymerization.

20 Another object of the present invention is providing a heating means can heat process gases more efficiently and keep their temperature constant, and it can also maintain the temperature of vapor and prevent further condensation.

25 Another object of the present invention is stabilizing the flow of liquid prior to introduction to the reaction chamber. This would improve the repeatability of film deposition.



Another object of the present invention is to provide a purging procedure to purge the liquid between the valve and injector to prevent polymerization and other processing to be executed simultaneously. This in turn would improve machine uptime.

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The present invention is a heating injection apparatus for vapor liquid delivery system. This apparatus implements a thermostat device to heat process gases and an inert gas purging module to isolate liquid source from other process gases, the heating injection apparatus includes a inert gas purging parts and a thermostat device. The heating source of this thermostat device can be a heating coil or infrared ray, and the temperature setting of thermostat device can be adjusted to meet liquid source requirement.

15 In accordance with the present invention, an inert gas purging part includes a liquid injector, a three-way valve, an exhausting branch and a purging nozzle. Liquid source resides in the front of a liquid injector, and this liquid source will be injected into a gas line through a liquid injector. The three-way valve disposing between the liquid source and liquid injector, and the three-way valve is used to control access of three pathways here and to isolate from process gases. One passageway of the three-way valve is connected to a purging gas that is used to purge the liquid source remains in the liquid injector. The purging procedure is used to purge the liquid source between the  
25 three-way valve and the liquid injector to prevent polymerization, thus improving machine uptime.

The thermostat device of the present invention is used to heat



gas to demanded production temperature before the gas enters  
reaction chamber. The thermostat device heats gas more efficiently,  
and quickly to keep the gas temperature constant. And the thermostat  
device can also maintain the temperature of vapor and prevent further  
5 condensation.

In accordance with the present invention, a liquid heating  
injection apparatus for vapor liquid delivery system improves the  
previous disadvantages of prior art. The liquid heating injection  
10 apparatus of present invention can continuously purging the liquid  
that remains inside the injector to prevent polymerization. And the  
liquid heating injection apparatus of the present invention solves a  
short heating problem relate to can not provide enough time to heat  
process gases, which has a high potential to reduce the temperature of  
15 vapor and cause further condensation.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

The foregoing aspects and many of the attendant advantages of  
20 this invention will become more readily appreciated as the same  
becomes better understood by reference to the following detailed  
description, when taken in conjunction with the accompanying  
drawings, wherein:

25 FIG. 1 is a scheme of vapor liquid delivery system of prior art.

FIG. 2 is a preferred embodiment scheme of vapor liquid  
delivery system according to the present invention.



## DESCRIPTION OF THE PREFERRED EMBODIMENT

Some sample embodiments of the invention will now be described in greater detail. Nevertheless, it should be noted that the present invention can be practiced in a wide range of other embodiments besides those explicitly described, and the scope of the present invention is expressly not limited except as specified in the accompanying claims.

The present invention is a liquid heating injection apparatus for vapor liquid delivery system, and this apparatus implements a thermostat device to heat process gases and an inert gas purging module to isolate liquid source from other process gases.

In FIG. 2, shown a preferred embodiment of liquid heating inject apparatus of the present invention for vapor liquid delivery system used. A liquid source 200, which resides in the front of liquid injector 205, the liquid source material in this preferred embodiment is TMCTS (1, 3, 5, 7, Tetramethylcyclotetrasiloxane)  $C_4H_{16}O_4Si_4$ , in another embodiment the liquid source can be another required materials. Liquid source 200 will be atomized and then injected into gas line 245 by liquid injector 205. There is a first three-way valve 210 disposing between liquid source 200 and liquid injector 205, and the first three-way valve 210 is used to control the access of the first three-way valve 210 and isolate from process gases.

The one passageway of the first three-way valve 210 is



connected to a purging gas provider 230 that is used to purge the liquid source 200 that remains inside the liquid injector 205. The purging gas is He in this preferred embodiment of the present invention. In some embodiments the purging gases can be N<sub>2</sub>, CO<sub>2</sub>, Ar or other inert gases.

In FIG.2, a branch 220 diverts to a pump 221. The branch 220 is used to stabilize pressure and speed of vapor flow of the vapor liquid delivery system. And the branch 220 can also be used as an exhausting branch. A second three-way valve 240 connected to the exhausting branch 220, gas line 245 and delivery line 250. And the purging gas 230 made the liquid source 200 has no chance to come in contact with other reactive process gases to induce polymerization, due to the purging gas always flushes the gas line 245 and is diverted to pump via exhausting branch 220. Purging procedures purge the liquid source remaining between the first three-way valve 210 and liquid injector 205, and then the exhausting branch 220 exhausts the purged gas. The purging procedure and other processes can be executed simultaneously and it would improve the machine uptime.

Continuously referring to FIG.2, a carrier gas 215 before entering the gas line 245 has been heated by a thermostat device 225. The carrier gas 215 is used to carry atomized liquid source 201 that is injected by liquid injector 205, and then the carrier gas 215 delivers the atomized liquid source 201 through delivery line 250 into gas-mixing device 255. The thermostat device 225 is used to heat the carrier gas 215 to the demanded production temperature before the carrier gas 215 enters the vapor liquid delivery system. The thermostat



device 225 heats the gas more efficiently, quickly and holds the gas temperature constant. And the thermostat device 225 can also maintains the temperature of vapor and prevent further condensation caused by a temperature decrease when carrier gas 215 is mixed with atomized liquid source 201.

In this preferred embodiment of the present invention, the temperature of the carrier gas to carry atomized liquid source TMCTS in the delivery line 250 at a temperature no less than 350°C, but not greater than 450°C, and the preferred temperature being 400°C. The heating source of thermostat device in this preferred embodiment of present invention can be heating coil or infrared ray, and the temperature setting of the thermostat device can be adjusted to meet the demand production requirement. In other embodiment the thermostat device can be other adjustable heating apparatus.

The atomized liquid source 201 had been carried by carrier gas 215 and other process gases will along the delivery line 250 enters a gas-mixing device 255, and the gas-mixing device 255 connect a reaction chamber 235 to performing chemical vapor deposition process.

Although specific embodiments have been illustrated and described, it will be obvious to those skilled in the art that various modifications may be made without departing from what is intended to be limited solely by the appended claims.